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The following amendment was allowed in a decision of the comptroller under Section 72 on 9 February 2009.

The amendment takes the form of a replacement specification.

Intellectual Property Office
14 October 2009

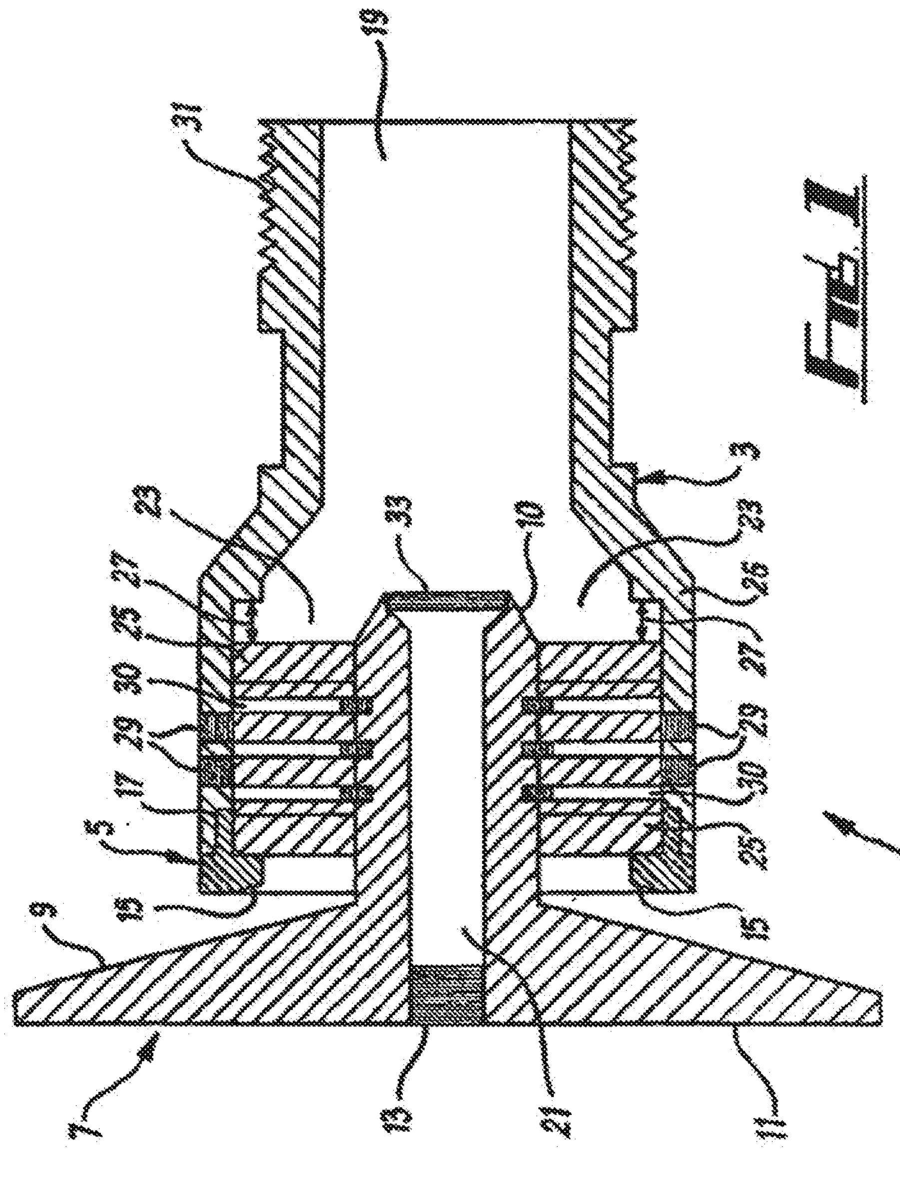

FIG. 1

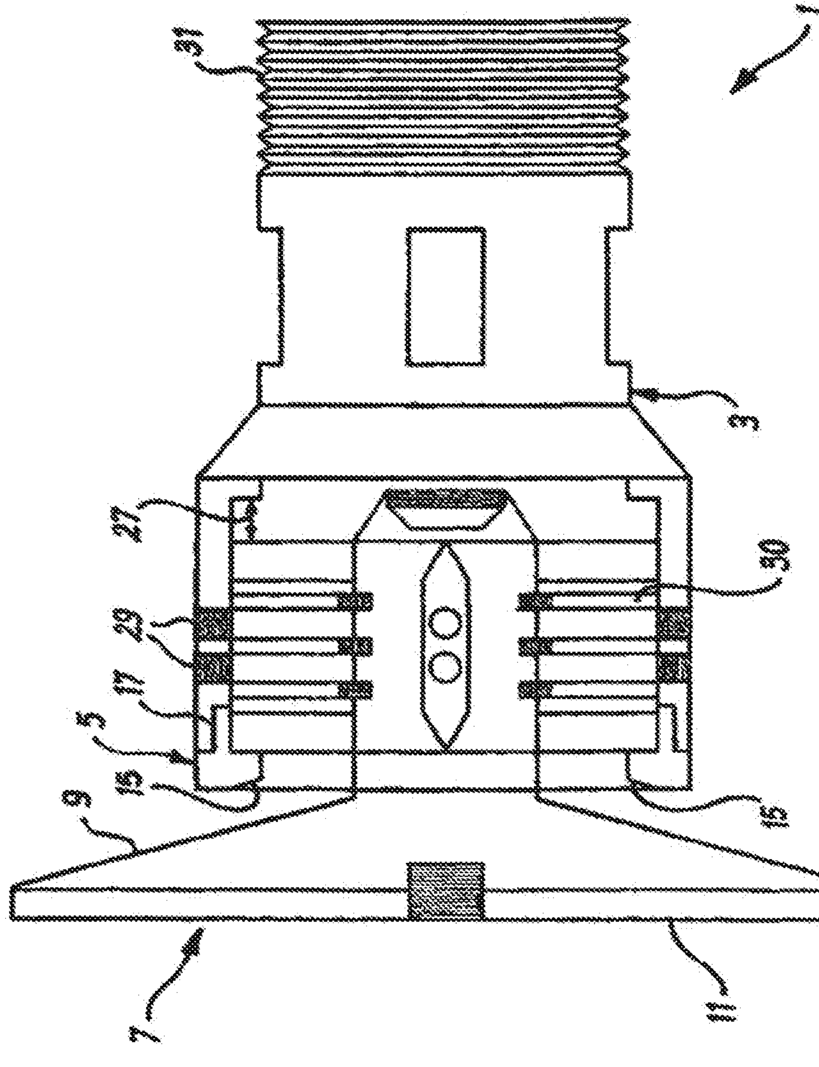

FIG. 2

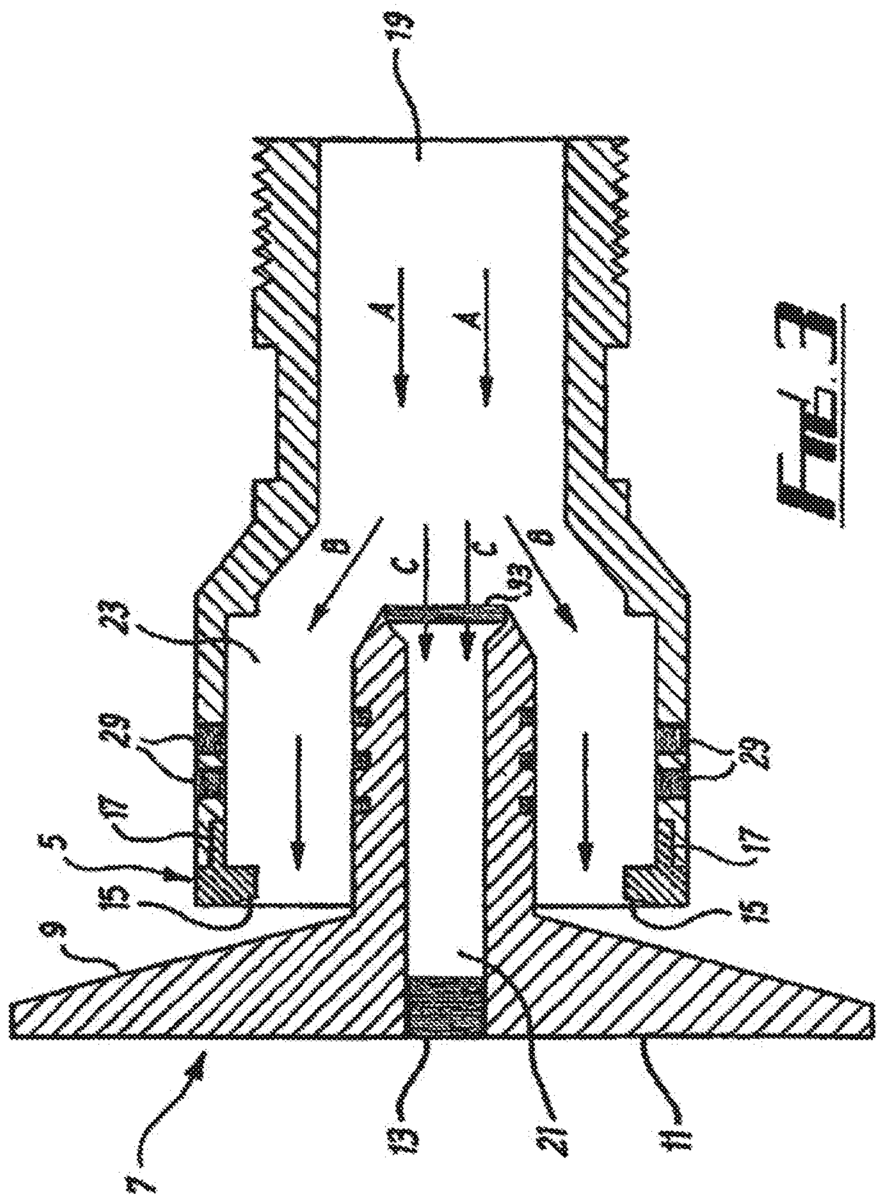

FIG. 3

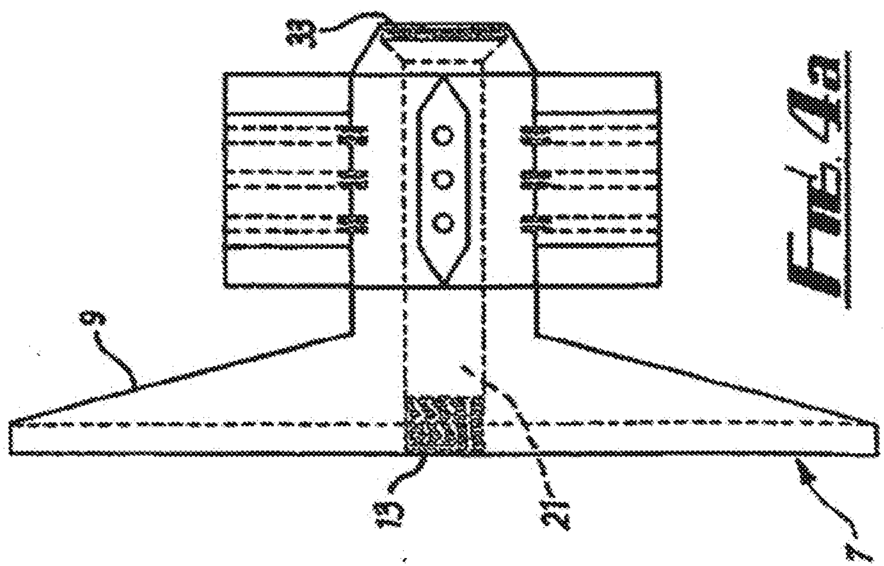

Fig. 4a

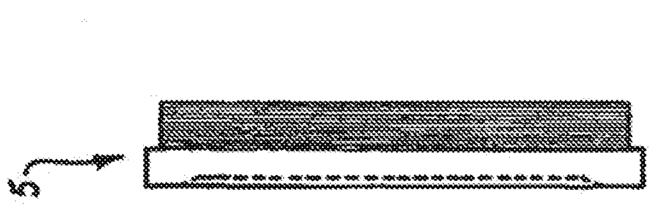

Fig. 4b

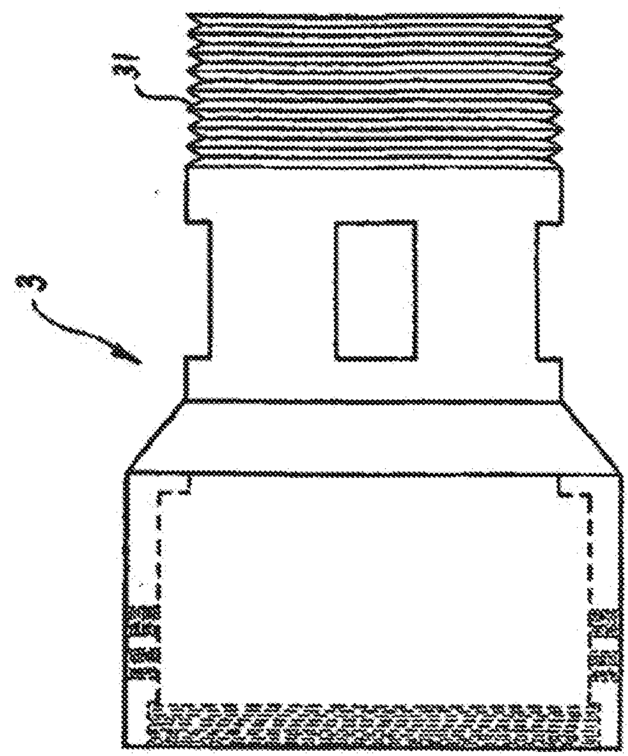

Fig. 4c

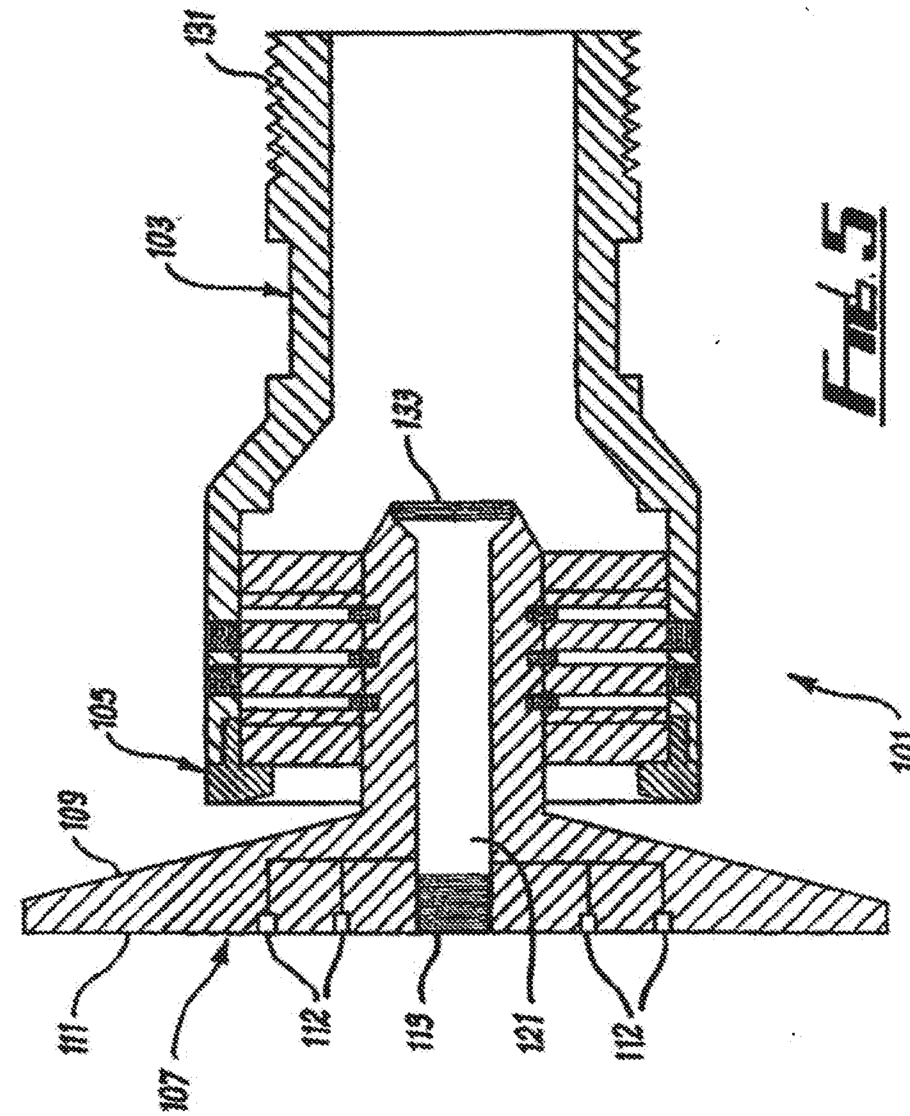

FIG. 5

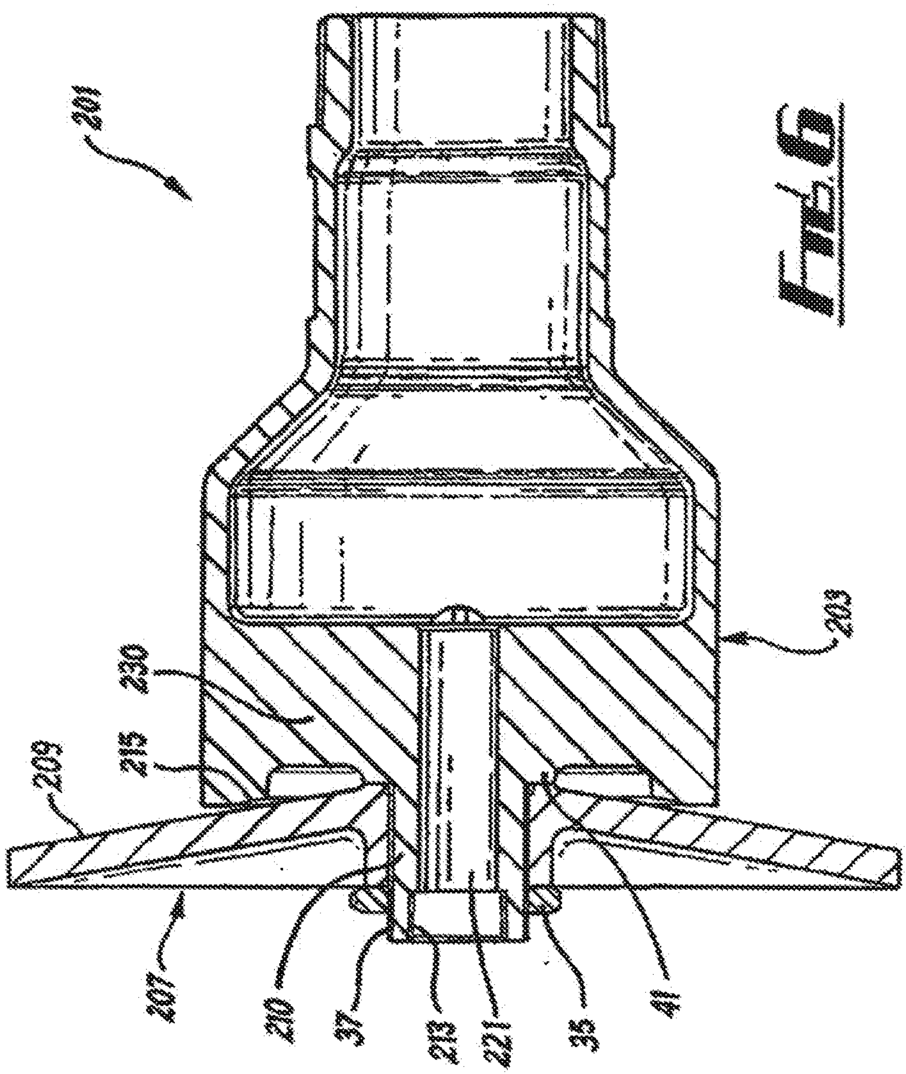

FIG. 6

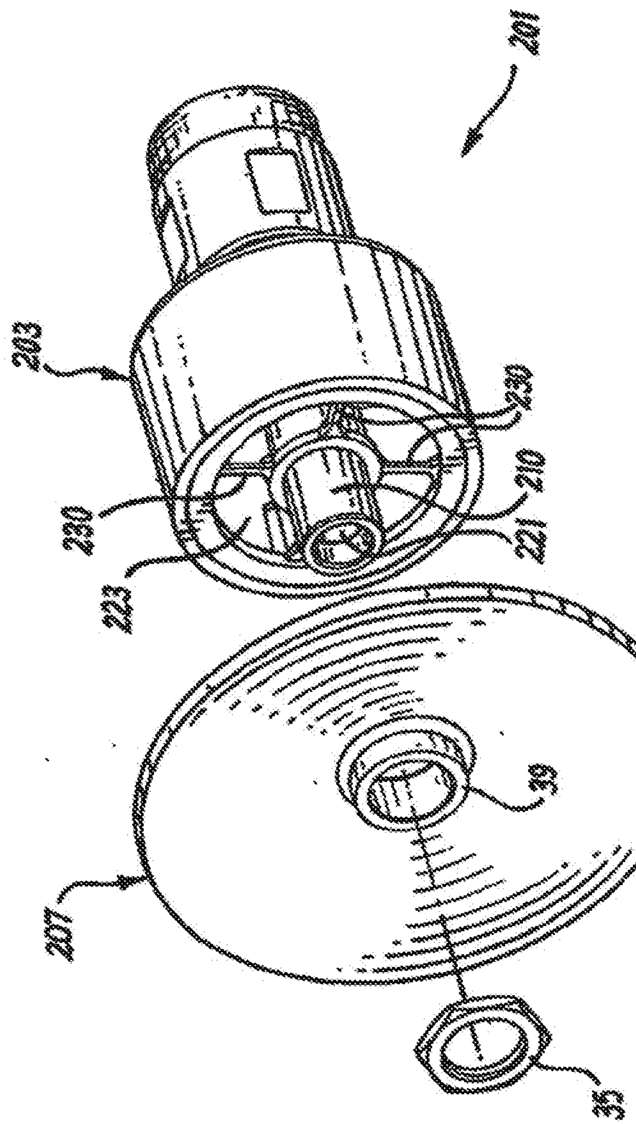

FIG. 7

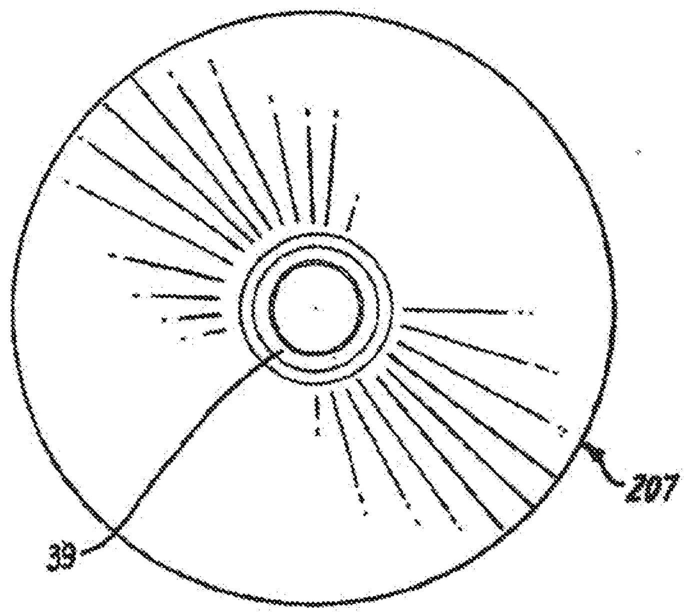

FIG. 8

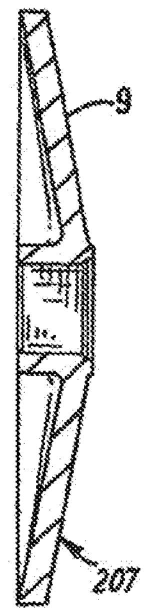

FIG. 9

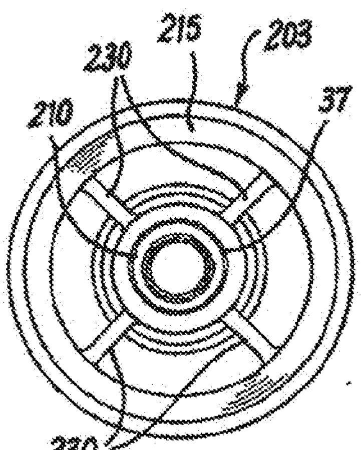

FIG. 10

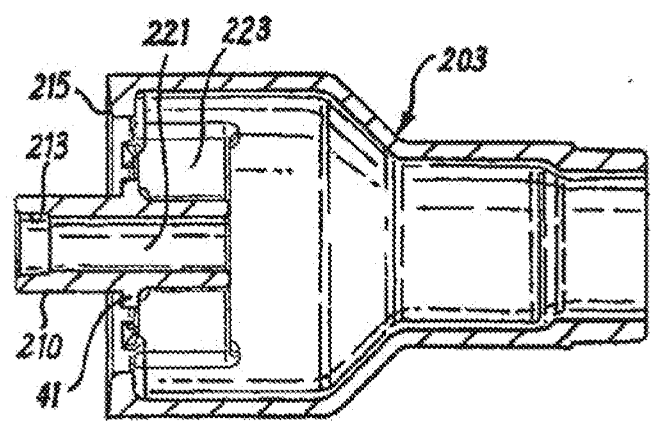

FIG. 11

Nozzle with fluid deflector arrangement

The present invention relates to a nozzle. In particular, but not exclusively, the present invention relates to a nozzle for use with a pressurised water source as typically used in the offshore environment.

During well completion, a surface well test package is used to evaluate well reservoir parameters and hydrocarbon properties. The evaluation of hydrocarbon properties requires the flow of a hydrocarbon fluid to the well test package from the well. Once the test has been made it is necessary to dispose of the hydrocarbon fluid. This is done by igniting the hydrocarbon fluid and flaring it from drilling rig, Floating Production Storage and Offloading vessels (FPSOs), Drillships, platforms and land rig burner booms. The flaring operation can cause temperatures to reach levels where the intense heat can compromise the integrity of the structure and rig safety equipment such as lifeboats, lifecrafts etc and create a hazardous working environment for personnel. One way of reducing the temperature around the flaring hydrocarbons is to form a water wall

around the flare, known as a rig cooling system and/or heat suppression and/or deluge system.

Systems of this type provide an outer wall of water designed to surround the flare which mimics the flare profile and/or shields the flare. The outer wall of water can take the form of a solid flat or conical shield or curtain and a central source which has a secondary function of generating a very fine mist of water through the central outlet of the dual nozzle design. The fine mist of water is designed to remove energy from the flare, and the outer wall of water is designed to create a barrier which also removes energy and therefore temperature from the flare.

In order to produce and shape a jet of water, it is necessary to connect a nozzle to a high-pressure water source and to engineer the nozzle such that an outer (typically cone-shaped) wall of water is formed in conjunction with a fine mist of water directed behind the flare.

An example of this type of nozzle is provided in UK Patent No. GB2299281. This document discloses a nozzle attachable to a high-pressure water source in which a narrow opening is positioned between a deflecting surface which opposes the direction of flow of water, and a guiding surface angled towards the direction of flow of the water and which defines the shape of the outer wall of water that is produced by this nozzle. It has been found that the combined action of the deflecting surface and guiding surface disrupts the water flow and causes energy to be dissipated thus lowering the water pressure.

It is an object of the present invention to provide an improved nozzle.

In accordance with a first aspect of the present invention, there is provided a nozzle for a hose or fixed pipework installation, the nozzle comprising:
a body;
a channel extending through the body of the nozzle; and
a fluid deflector arranged at or near the downstream end of the channel to determine the direction of flow of the fluid as it leaves the nozzle;
wherein the fluid deflector and the body of the nozzle together define a width of the channel at or near said downstream end, said channel width being variable by adjusting a position of the fluid deflector relative to the nozzle body, and the nozzle comprises a self-cleaning mechanism for adjusting the channel width.

Fluid flowing along the channel may impinge upon the fluid deflector and may travel along a surface of the deflector and out of the nozzle, the direction of flow of the fluid as it leaves the nozzle thereby determined by the deflector. By this arrangement, the fluid deflector may serve to direct the fluid whilst minimising energy loss when compared to prior nozzles of the type where the fluid is thrown backwards onto a second directing surface which directs the fluid out of the nozzle.

The fluid deflector may be located in a fluid flow path extending through the nozzle along the channel.

Preferably, the fluid deflector and the body of the nozzle together define a width of the channel at or near said downstream end. The fluid deflector may have a deflecting surface positioned relative to the end of the channel to define the width of the channel at or near the downstream end of the channel. Accordingly, at least part of the channel may be defined between the deflecting surface and an outlet surface of the body. The deflecting surface and the body outlet surface may be substantially parallel.

The deflector surface may be disposed at an obtuse angle relative to a main axis of the body and is preferably angled away from the body.

The fluid deflector may be movably mounted relative to the body, to enable adjustment of a position of the deflector relative to the body. This may facilitate adjustment of the channel width.

Preferably, the channel is provided with a gap or space suitable for accommodating a spacer to alter the position of the fluid deflector relative to the end of the channel, thereby varying the width of said channel.

Alternatively, the deflector may be threadably coupled to the body, such that rotation of the deflector relative to the body may advance and / or retract the deflector relative to the body, thereby facilitating adjustment of the channel width. The nozzle may include a retaining member, such as a nut, clip or the like, for retaining

the deflector in a desired position relative to the body, to fix the channel width.

The mechanism may be hydraulic, electrical, electro-mechanical or mechanical, and may comprise an actuator for controlling a position of the deflector relative to the body, for adjustment of the channel width. The actuator may be adapted to be activated to move the deflector to increase the channel width, in order to facilitate flow of any debris such as particulate matter trapped in the nozzle and impeding fluid flow. The mechanism may comprise one or more sensors for detecting the presence of trapped debris. For example, the nozzle may include a pressure sensor or flowmeter for detecting an increase in pressure or reduction in fluid flow rate through the channel indicative of the presence of trapped debris impeding fluid flow.

Preferably, the fluid deflector comprises the deflecting surface and a central beam, shaft, boss or the like extending from the deflecting surface into the body of the nozzle, the central beam being attachable to the body of the nozzle.

Preferably, the nozzle is further provided with pressure sensing means.

Preferably, the channel extending through the body of the nozzle is an annular channel, but may be of any alternative, suitable shape.

Preferably, the nozzle further comprises a central channel extending through the body of the nozzle.

Preferably, the central channel extends through the central beam of the deflector.

The pressure sensing means may be located in the fluid deflector.

Optionally, the pressure sensing means is located in the body of the nozzle.

Preferably, the fluid deflector means further comprises filter coupling means for coupling a filter to the upstream end of the central channel.

Preferably, the fluid deflector means further comprises nozzle-coupling means for coupling a nozzle to the downstream end of the central channel.

More preferably, said nozzle coupling means is connectable to a nozzle for producing a fine spray of fluid.

Preferably, the fluid deflector means is frusto-conical and is thus provided with a frusto-conical deflecting surface, angled away from the direction of fluid flow. Alternatively, the deflecting surface may be any other suitable shape and the deflector may be frusto-conical with an arcuate deflecting surface, in cross-section.

More preferably, the frusto-conical deflecting surface extends beyond the maximum width of the channel to direct the flow of fluid.

Preferably, the nozzle is generally cylindrical in shape.

Preferably, the nozzle is further provided with sensor means attached thereto.

More preferably, the sensor means are attached to the fluid deflector means.

More preferably, the sensor means are embedded in a front surface of the fluid deflector means.

The sensor means can be temperature sensors, gas sensors, or other suitable sensors and may be hardwired through the nozzle to provide information on the temperature, gas composition pressure or other information.

The nozzle may be constructed in a single piece.

It will be understood that the nozzle may be suitable for use with a wide range of diameters of hoses or pipes of a pipework installation, and may therefore be dimensioned accordingly. However, embodiments of the invention may be particularly suited for use with hoses/pipes having diameters in the range of 1½" to 2" (approximately 38mm to 51mm), whilst other embodiments may be particularly suited for use with hoses/pipes having diameters of around 6" (approximately 152 mm) or more.

In accordance with a second aspect of the invention there is provided a kit of parts for a nozzle, the kit of parts comprising a body, a fluid deflector and a coupling means adapted to connect the fluid deflector to the body, wherein the kit of parts when assembled forms a nozzle according to the first aspect of the invention.

Further features of the nozzle are defined in relation to the first aspect of the invention.

The present invention will now be described by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a longitudinal cross-sectional view of a nozzle in accordance with an embodiment of the present invention;

Figure 2 is a further, partial cross-sectional view of the nozzle of Figure 1;

Figure 3 is another sectional view of the nozzle of Figure 1 in which the fluid flow paths are shown;

Figure 4a shows the deflector of the present invention, Figure 4b shows a coupling ring as used in the present invention and Figure 4c shows a body of the nozzle of the present invention;

Figure 5 shows a second embodiment of the present invention in which sensors are embedded into the front surface of the deflector means;

Figure 6 is a longitudinal cross-sectional view of a nozzle in accordance with a third embodiment of the present invention;

Figure 7 is an exploded perspective view of the nozzle of Figure 6;

Figures 8 and 9 are end and sectional views, respectively, of a deflector forming part of the nozzle of Figure 6; and

Figures 10 and 11 are end and side views, respectively, of a body forming part of the nozzle of Figure 6.

In the embodiment of the present invention shown in Figure 1, the nozzle 1 is constructed from three separate components. These are the nozzle body 3, the coupling ring 5 and the deflector 7.

The deflector 7 is provided with a front surface 11, a deflecting surface 9 which is angled away from the direction of fluid flow and a central beam or projection 10 which extends into the nozzle body 3 and provides a central channel 21.

The central channel 21 has a filter coupler 33 to which a wire-mesh cone known as a Witch's Broom can be attached. The purpose of this filter is to prevent particulates from entering the central channel. A second coupler 13 is attached to the downstream end of the central channel 21. The second coupler 13 is used to attach a further nozzle for shaping the water flow. Suitably, the nozzle is designed to produce a fine spray or fog of water.

Typically, the water used will be filtered upstream of the nozzle. Therefore, the size of particulates entering the nozzle will have a maximum determined by the upstream filter.

The gap between the central beam 10 and the nozzle body 3 defines an outer channel which is annular in shape. Support means in the form of fins 30 extend between the central beam 10 and the nozzle body 3 to secure the deflector 7 in place. Grub screws are used to further secure the deflector 9 in position. The nozzle may also be provided with a pressure indicator switch (not shown) located in the deflector surface or on the body of the nozzle. Fixed rings 25 are also included to position the deflector within the nozzle body 3.

The box section 26 provides abutting surfaces at either end thereof, and further provides an adjustable gap 27

which can be reduced in size by the inclusion of further spacer rings (not shown). Typically, an additional spacer ring would be introduced at the downstream end of the box section 26 thereby moving the deflector in an upstream direction and therefore reducing the size of the adjustable gap 27. This also reduces the width of the end of the channel as defined by the distance between the deflector surface 9 and the chamfered surface 15.

It will be noted that the deflector 7 is generally frusto-conical or cone-shaped. The chamfered surface 15 provides a way of smoothing the flow of fluid at the downstream end of channel 23, and as a consequence creates a more laminar fluid flow.

Providing an adjustable gap between the deflector surface 9 and the chamfered surface 15 provides water flow having different profiles. For example, where the gap between the chamfered surface 15 and the deflector surface 9 is small, the flow of water from the nozzle will be disrupted and this will create a non-uniform flow to produce a more diffuse wall of water. Where this distance is larger the flow will be more laminar and the wall of water will be less diffuse.

The chamfered surface 15 forms part of a coupling ring which is attached to the nozzle body 3. The upstream end of the nozzle body 3 is provided with a nozzle coupler 31, for coupling the nozzle 1 to a hose or pipework. The nozzle 1 is dimensioned for coupling to a 6" (approximately 152mm) diameter hose or pipe, although it will be understood that the nozzle 1 may be provided for a hose or pipe of any suitable diameter. In this example,

the coupler 31 is a screw thread. As the water has been filtered upstream, the gap between surfaces 9 and 15 will provide a flow path that is not restricted by the presence of large particulates. Accordingly, this will not block or inhibit the performance of the nozzle. Figure 2 provides a further, partial cross-sectional view of the present invention and shows the outer surface of the central beam 10 and the fins 30. The features of this drawing are identical to the features shown in Figure 1.

Figure 3 shows the water flow path through the nozzle.

The water flows through the main channel 19 at the upstream end of the nozzle in direction A. The flow is then split into two portions which flow through the central channel 21 in direction C and through the outer channel 23 in direction B. A filter (not shown) is attached to the filter coupler 33. This prevents particulates from entering the central channel and directs them out through the outer annular channel 23. This is desirable because the purpose of the central channel is to provide a fine mist of water by using a fine nozzle (not shown). The use of a filter prevents particulates from entering the fine nozzle, and thereby blocking it.

As the water flows through the outer channel 23 in direction B, the water is deflected from surface 9 outwards in a pre-determined direction. This direction is determined by the angle of the deflection surface 9 with respect to the direction of bulk flow through the channel 23. In this example, the surface 9 is at an

angle of approximately 105° with respect to the central beam. Clearly, therefore, the deflector surface 9 is angled away from the direction of flow B.

Advantageously, it has been found that the use of a deflector surface in this configuration means that the general bulk flow B loses energy only when it is deflected from the surface 9. Therefore, it is possible to produce a more efficient nozzle that requires a lower water pressure to produce a wall of water that extends a predetermined distance from the nozzle than would be possible with the prior art nozzles. In addition, it is possible to produce walls of water that extend further with the same pressure than in the prior art.

It should be noted that in the prior art the exiting water impinges on a first surface, and is thrown backwards onto a second directing surface for directing the water out from the nozzle. This causes the water to lose energy and therefore causes a reduction in overall pressure.

In addition, the present invention may also be provided with means for altering the width of the gap between the chamfered surface 15 and the deflector surface 9. In order to alter this distance, a spacer ring (not shown) is introduced into the nozzle body so as to reduce the width of gap 27. A number of rings of different width can be used to produce different gap sizes.

Figures 4a, 4b and 4c show the components from which an embodiment of the present invention can be made. Figure 4a shows the deflector means 7, Figure 4b shows the

coupling ring 5 and Figure 4c shows the nozzle body 3. It is convenient for the nozzle of the present invention to be constructed in three parts in this manner as it allows easy cleaning and maintenance of the nozzle.

Figure 5 shows a second embodiment of the present invention in which sensors 112 are embedded into the front surface 111 of a nozzle 101. The sensors can be hard-wired and/or wirelessly and/or acoustically connected through the central channel 121 to a position upstream where data from the sensors can be analysed. The sensors can be temperature sensor, gas composition sensors or any other desired sensor.

In the examples of Figures 1-4 and 5, the fins 30 may be shaped to affect the flow of water through the outer channel 23.

Turning now to Figure 6, there is shown a longitudinal cross-sectional view of a nozzle in accordance with a third embodiment of the present invention, the nozzle indicated generally by reference numeral 201. Like components of the nozzle 201 with the nozzle 1 of figures 1-4c share the same reference numerals incremented by 200.

The nozzle 201 is dimensioned for coupling to a hose or pipe of a diameter in the range of 1.5"-2" (approximately 38mm-51mm), although it will again be understood that the nozzle 201 may be provided on a hose or pipe of any suitable diameter, and thus dimensioned accordingly.

The nozzle 201 is similar to the nozzle 1 of Figures 1-4c, except that the nozzle 201 comprises two main components, a nozzle body 203 and a fluid deflector 207 which is coupled to the nozzle body 203. As will be described below, the deflector 207 is secured to the nozzle body 203 by a retaining member in the form of a nut 35.

The nozzle 201 is shown in more detail in the exploded perspective view of Figure 7. Also, the deflector 207 is shown separately from the body 203 in the end and sectional views of Figures 8 and 9, and the body 203 is shown with the deflector 207 removed in the end and sectional views of Figures 10 and 11.

Only the main differences between the nozzle 203 and the nozzle 1 of figures 1-4c will be described herein in detail.

The body 203 includes a central beam or a shaft 210 which is located by fins 230 that are formed integrally with the body 203. The beam 210 is threaded at 37 and the deflector 207 includes a hub 39 which is internally threaded for engaging the beam threads 37. In this fashion, the deflector 207 may be coupled to the body 203 and the gap between the deflector surface 9 and a chamfered surface 215 of the body 203 may be adjusted by rotating the deflector 207, causing the deflector to advance or retract along the beam 210 relative to a main part of the body 203. The deflector 207 is locked in position by a retaining member in the form of a threaded nut 35 which engages the beam threads 37 and abuts the deflector 207. If required, however, spacer rings (not

shown) may be provided between a shoulder 41 of the body 203 and the deflector 207.

In a variation, the deflector 207 may include a smooth hub 39 and may be clamped in position between the shoulder 41 of the body 203 and the nut 35. Spacer rings may be located between the shoulder 41 and the deflector 207 to increase the spacing between the deflector surface 209 and the chamfered surface 215 on the body 203.

In a similar fashion to the nozzle 1, the nozzle 201 defines a central flow channel 221 whilst the body 203 defines an outer flow channel 223. In use, fluid flow is split between the inner and outer channels 221, 223 and a further nozzle may be provided coupled to a coupler 213 on the beam 210.

The nozzle 201 additionally includes a self-cleaning mechanism (not shown) for adjusting the channel width at the downstream end, that is the space or gap between the deflector surface 209 and the chamfered surface 215 of the body 203. The mechanism is typically hydraulic, electrical, electro-mechanical or mechanical and includes an actuator for controlling adjustment of the channel width. For example, the mechanism may comprise a motor for adjusting a position of the deflector 207 relative to the body 203. This may be achieved by rotating the deflector 207 to advance or retract the deflector along the beam 210 either by direct rotation of the deflector 207 relative to the beam 210, or the beam 210 may be provided as a separate component coupled to or integral with the deflector 207, and may be rotatable relative to the body 203.

The self-cleaning mechanism may be actuated to increase the channel width between the deflector surface 209 and the chamfered surface 215 of the body 203 in response to the detection of the presence of trapped debris, such as particulate matter in the nozzle 203. Such debris may cause a reduction in the flow rate of fluid through the nozzle and/or an increase in fluid pressure, which may be detected by appropriate sensors. On detection of such a situation, the self-cleaning mechanism may automatically activate the actuator to adjust the position of the deflector 207, increasing the channel width and allowing clearance of the blockage.

The embodiments of the present invention described herein show a nozzle designed for manufacture using a lathe (Figures 1 to 5) and by casting (Figures 6 to 11). Details of the component design may change where other manufacturing techniques are used to make the nozzle. Examples of alternative manufacturing techniques are lost wax processing or a combination of techniques.

In addition, the nozzle may be made in modular form or as a single component.

It is also envisaged that the present invention could be used for escape route protection, well control and where blowouts occur.

Improvements and modifications may be incorporated herein without deviating from the scope of the invention.

CLAIMS

1. A **hydrocarbon well-test flare** nozzle for a hose or fixed pipework installation, the nozzle **adapted for forming a water wall around a flare in a hydrocarbon well-test operation and** comprising:
a body **having an inlet and an outlet**;
a channel extending through the body of the nozzle **between the inlet and the outlet**; and
a fluid deflector arranged at or near the downstream end of the channel **adjacent the body outlet, the deflector determining** ~~to determine~~ the direction of flow of ~~the~~ fluid as it leaves the nozzle;
wherein the fluid deflector and the body of the nozzle together define a width of the channel at or near said downstream end, said channel width being variable by adjusting a position of the fluid deflector relative to the nozzle body~~,~~;
and wherein the body inlet, the body outlet and the fluid deflector are arranged on a longitudinal axis of the body such that, in use, fluid flows from the body inlet along the channel to the body outlet and impinges on the fluid deflector with minimal energy loss prior to impingement on the fluid deflector;
and **further wherein** the nozzle comprises a self-cleaning mechanism for adjusting the channel width.

2. A nozzle as claimed in Claim 1 wherein the fluid deflector includes a deflecting surface positioned relative to the end of the channel to define the

width of the channel at or near the downstream end of the channel.

3. A nozzle as claimed in Claim 2 wherein at least part of the channel is defined between the deflecting surface and an outlet surface of the body.

4. A nozzle as claimed in Claim 3 wherein the deflecting surface and the body outlet surface are substantially parallel.

5. A nozzle as claimed in any one of Claims 2 to 4 wherein the deflector surface is disposed at an obtuse angle relative to a main axis of the body.

6. A nozzle as claimed in Claim 5 wherein the deflector surface is disposed at an angle of approximately 105 degrees relative to a main axis of the body.

7. A nozzle as claimed in any preceding claim wherein the fluid deflector is movably mounted relative to the body, to enable adjustment of a position of the deflector relative to the body, to facilitate adjustment of the channel width.

8. A nozzle as claimed in any preceding claim wherein the channel is provided with a gap or space suitable for accommodating a spacer to alter the position of the fluid deflector relative to the end of the channel, thereby varying the width of said channel.

9. A nozzle as claimed in any preceding claim wherein the deflector is threadably coupled to the body, such

that rotation of the deflector relative to the body advances and/or retracts the deflector relative to the body, thereby facilitating adjustment of the channel width.

10. A nozzle as claimed in any preceding claim wherein the mechanism comprises an actuator and one or more sensors, the actuator moving the deflector in response to a detected ~~increase~~ reduction in fluid flow rate indicative of trapped debris in the nozzle.

11. A nozzle as claimed in any one of Claims 2 to 10 wherein the fluid deflector comprises the deflecting surface and a central beam extending from the deflecting surface into the body of the nozzle, the central beam being attachable to the body of the nozzle.

12. A nozzle as claimed in any preceding claim wherein the channel extending through the body of the nozzle is an annular channel.

13. A nozzle as claimed in any preceding claim wherein the nozzle further comprises a central channel extending through the body of the nozzle.

14. A nozzle as claimed in Claim 13 wherein the central channel extends through the central beam of the deflector.

15. A nozzle as claimed in any preceding claim wherein the nozzle is further provided with sensor means.

16. A nozzle as claimed in Claim 15 wherein the sensor means is located in the fluid deflector.

17. A nozzle as claimed in Claim 16 wherein the sensor means are embedded in a front surface of the fluid deflector.

18. A nozzle as claimed in Claim 15 wherein the sensor means is located in the body of the nozzle.

19. A nozzle as claimed in any one of Claims 13 to 18 wherein the nozzle further comprises filter coupling means for coupling a filter to the upstream end of the central channel.

20. A nozzle as claimed in any one of Claims 13 to 19 wherein the nozzle further comprises nozzle-coupling means for coupling a nozzle to the downstream end of the central channel.

21. A nozzle as claimed in any preceding claim wherein the fluid deflector is frusto-conical and is thus provided with a frusto-conical deflecting surface, angled away from the direction of fluid flow.

22. A nozzle as claimed in Claim 21 wherein the frusto-conical deflecting surface extends beyond the maximum width of the channel to direct the flow of fluid.

23. A kit of parts for a nozzle, the kit of parts comprising a body, a fluid deflector and a coupling means adapted to connect the fluid deflector to the

body, wherein the kit of parts when assembled forms a nozzle according to Claim 1.